Supplemental results

Experimental conditions

The abiotic data are shown in Figure S4 and Table S1. Briefly, the CO_2 concentration differed significantly between treatments (p<0.000001), and the AquaControllers led to precise regulation of the CO_2 in each of the six mesocosms. Irradiance (~50cm below the surface) was ~7,000-7,500 Lux (approximately ~100 μmol photons m^{-2} s^{-1} according to the equations of Thimijan & Heins [1]). The natural photosynthetically active radiation (PAR) coming from outside the mesocosms was only 22.1±12.9 μmol photons m^{-2} s^{-1} (SE for this & all future error terms unless noted otherwise) at 10:00, 5.3±1.2 μmol photons m^{-2} s^{-1} at 12:00, 3.7±1.1 μmol photons m^{-2} s^{-1} at 15:00, and 0.2±0.1 μmol photons m^{-2} s^{-1} at 18:00 at the seawater surface since shade cloth was draped over the tanks; as such, the vast majority of the irradiance experienced by the seagrass blades was from the artificial lights (discussed in the main text).

Although temperature control was generally precise throughout the 12-week experiment, one chiller broke down in one of the three control CO_2 mesocosms during the third week, leading to a brief temperature spike evident in Figure S4A. Throughout the study, the pH was maintained between 8.20 and 8.23 in the control mesocosms and 7.70 and 7.73 in the high-CO_2 ones (Figure S4B). However, no pH adjustments for the AquaController were made between the 1st and 4th weeks and between the 13th and 14th weeks; this caused the pH values (as measured by the YSI instrument) to 1) increase gradually from the 1st to the 4th week and 2) decrease after the 13th week. Such pH variation also influenced TA, the CO_2 concentration, [HCO_3^-], and the aragonite saturation state during these periods.

Salinity ranged from 34.7 to 35 (Figure S4C) and did not vary significantly between CO_2 treatments (Table S2). The concentration of DO varied from 6 to 10 mg L^{-1} in all mesocosms (Figure S4D), and DO decreased with increasing temperatures. There were no differences in

temperature and DO between control and high-CO_2 mesocosms (Table S2). The TA (Figure S4E), CO_2 (Figure S4F), and [HCO_3^-] (Figure S4G) were significantly higher in the high-CO_2 mesocosms (Table S2), and TA and [HCO_3^-] decreased in both high-CO_2 and control mesocosms as temperatures rose (Table S2). The CO_2 concentration (Figure S4F) was affected by both temperature and time nested within the experimental stage (p=0.005).ΩAr (Figure S4H) was higher in the control CO_2 mesocosms, as expected (Table S2). The nutrient concentrations (Figure S4I-K) did not differ significantly between the control and high-CO_2 mesocosms (Table S2); however, [PO_4^{3-}] (Figure 4L) decreased when the temperature was increased from 25 to 28ºC, yet increased when the temperature was increased from 28 to 31ºC. Nitrate (Figure S1I) and nitrite (Figure S1J) concentrations showed the contrasting trend, increasing from 25 to 28ºC and then decreasing from 28 to 31ºC.

Supplemental reference

1. Thimijan, R.W.; Heins, R.D. Photometric, radiometric, and quantum light units of measure: a review of procedures for interconversion. *Hort Science*. **1983**, 18(6), 818-822.

Table S1. The mean values (±SE, n=3) of the abiotic parameters in the ambient (i.e., control) and high-CO_2 mesocosms under three different temperature treatments. AC=AquaController.

	25ºC		28ºC		31ºC	
	high CO_2	**ambient CO_2**	**high CO_2**	**ambient CO_2**	**high CO_2**	**ambient CO_2**
AC-pH	7.73±0.00	8.20±0.00	7.70±0.00	8.22±0.00	7.70±0.00	8.23±0.00
AC-Temperature (ºC)	25.1±0.0	25.1±0.0	28.0±0.0	28.0±0.0	30.8±0.0	30.8±0.0
HOBO-Temperature (ºC)	25.4±0.0	25.6±0.0	28.3±0.0	28.4±0.0	31.0±0.0	31.1±0.0
PAR (µmol photons m^{-2} s^{-1})	103.5±1.5	99.0±1.8	101.2±1.4	99.1±1.1	96.3±2.0	100.9±1.9
YSI-pH	7.92±0.01	8.18±0.01	7.61±0.01	7.94±0.01	7.58±0.01	7.92±0.02
YSI-Temperature (ºC)	25.1±0.0	25.2±0.0	28.1±0.0	28.2±0.02	30.9±0.0	31.0±0.0
YSI-DO (mg L^{-1})	6.19±0.15	6.22±0.15	5.92±0.16	5.91±0.17	5.47±0.14	5.46±0.15
YSI-Salinity	34.8±0.0	34.8±0.0	34.7±0.0	34.8±0.05	34.7±0.0	34.7±0.0
TA (µmol kg^{-1} SW)	2,309±235	2,250±219	2,300±12	2,204±6	2,143±59	1,898±126
[CO_2] (ppm)	1,372±159	444±50	1,210±88	381±28	1,220±136	286±51
[HCO_3^-] (mmol kg^{-1} SW)	2,081±208	1,761±170	2,040±25	1,667±25	1,883±64	1,352±122
Ω_{Ar}	1.49±0.26	3.18±0.49	1.71±0.09	3.50±0.19	1.72±0.03	3.49±0.10
[PO_4^{3-}] (mg L^{-1})	0.02±0.01	0.02±0.01	0.01±0.00	0.01±0.00	0.05±0.01	0.06±0.00
[NH_4^+] (mg L^{-1})	0.04±0.01	0.04±0.01	0.03±0.01	0.03±0.01	0.04±0.01	0.04±0.01
[NO_2^-] (mg L^{-1})	0.001±0.001	0.001±0.001	0.004±0.002	0.007±0.006	0.004±0.001	0.003±0.001
[NO_3^-] (mg L^{-1})	0.004±0.002	0.007±0.001	0.004±0.004	0.004±0.003	0.019±0.006	0.011±0.004

Table S2. Nested, repeated measures ANOVA *F*-values for water quality parameters throughout the three-month study. Please note that a "Tank(CO_2)" term was a random effect in the mixed model. DO=dissolved oxygen. TA=total alkalinity. temp.=temperature. ***p*<0.05, ***p*<0.01, ****p*<0.001.**

Parameter	CO_2	Temp.	CO_2 × temp.	CO_2(Temp.)	Week(Temp.)	Week
df	1	2	2			
YSI-pH	**624*****	**8.83*****	0.8025	**281*****	**6.84*****	7.18
YSI-Temp. (°C)	2.54	**>10^5*****	2.27	**39.2***	0.753	**8 x 10^4*****
YSI-DO (mg L^{-1})[a]	0.0029	**50.29*****	0.0051	0.0073	**14.3*****	**54.5*****
YSI-Salinity[b]	0.235	**11.5*****	0.239	**3.27***	**13.0*****	**88.0*****
TA (µmol kg^{-1} SW)[b]	**37.1*****	**70.25*****	**3.59***	**3.87***	**38.3*****	**23.8*****
[CO_2] (ppm)[c]	**267*****	**20.36*****	**4.21***	**303.4*****	**10.74*****	0.797
[HCO_3] (mmol kg^{-1} SW)[b]	**317*****	**79.2*****	1.71	**145*****	**38.8*****	**41.7*****
Ω_{Ar}[a]	**258*****	**13.4*****	0.0423	**64.1*****	**7.048*****	**2.017***
[PO_4^{3-}] (mg L^{-1})[b]	0.0024	**58.3*****	1.30	0.328	**4.16****	**11.9*****
[NH_4^+] (mg L^{-1})[b]	1.30	**3.89***	0.4084	0.156	**19.6*****	**16.2*****
[NO_2^-] (mg L)[b]	0.775	**16.9*****	0.0054	0.0721	**8.99*****	**8.68*****
[NO_3^-] (mg L^{-1})[b]	1.56	**33.0*****	3.00	0.580	**14.3*****	**16.3*****

[a]rank-transformed data. [b]box-cox-transformed data. [c]log-transformed data.

Table S3. The mean values of the physiological response variables of the high and ambient (i.e., control) CO_2 mesocosms at different temperatures (mean±SE, n=3).

	25ºC		28ºC		31ºC	
	high CO_2	**ambient CO_2**	**high CO_2**	**ambient CO_2**	**high CO_2**	**ambient CO_2**
Fv:Fm	0.79±0.00	0.79±0.00	0.80±0.00	0.80±0.00	0.80±0.00	0.81±0.00
Productivity (mg DW shoot^{-1} d^{-1})	0.90±0.05	0.76±0.10	1.32±0.10	1.14±0.03	1.78±0.14	1.63±0.37
Relative growth rate (mg DW g^{-1} d^{-1})	4.38±0.35	4.90±0.89	6.58±0.37	7.02±0.48	9.40±0.67	9.41±0.26
Leaf growth rate (mm shoot^{-1} d^{-1})	3.61±0.55	3.59±0.44	6.93±0.24	6.85±0.39	8.34±0.33	8.19±0.95
Shoot density (no. 10 cm^{-2})	18.2±1.0	19.2±2.0	19.2±1.4	20.1±2.1	19.2±1.2	19.4±1.6
Rate of shoot density increase (% week^{-1})	4.19±1.43	2.28±0.46	0.14±0.58	-0.20±0.37	-0.07±0.23	-1.25±0.79
Aboveground biomass (mg DW shoot^{-1})	59.4±6.9	57.1±9.1	64.6±2.7	51.5±4.9	65.4±13.3	59.8±16.2
Underground biomass (mg DW shoot^{-1})	154.9±6.2	105.3±10.6	137.6±5.9	113.7±2.9	128.0±13.9	113.5±23.3
Underground/ aboveground (U/A) ratio	3.26±0.59	1.92±0.32	2.16±0.06	2.36±0.29	2.07±0.27	1.97±0.18
Aboveground decomposition rate (% d^{-1})	1.65±0.06	1.42±0.20	2.12±0.20	2.46±0.12	2.47±0.27	2.58±0.26
Underground decomposition rate (% d^{-1})	0.46±0.06	0.28±0.11	0.92±0.15	1.16±0.33	0.88±0.21	1.63±0.31
Root carbon content (%)	34.1±0.5	33.7±0.1	29.2±1.2	31.5±0.3	32.4±0.2	31.9±0.7
Root nitrogen content (%)	1.4±0.1	1.5±0.0	1.2±0.1	1.4±0.1	1.3±0.0	1.4±0.1
Root C:N ratio	24.6±1.3	21.8±0.2	26.0±1.6	22.7±1.3	24.1±0.3	22.3±1.3
Rhizome carbon content (%)	34.0±0.8	33.9±1.8	32.7±0.3	32.1±0.2	34.5±1.1	35.4±5.2
Rhizome nitrogen content (%)	1.5±0.0	1.4±0.1	1.4±0.0	1.5±0.1	1.4±0.1	1.4±0.1

	25ºC		28ºC		31ºC	
	high CO_2	**ambient CO_2**	**high CO_2**	**ambient CO_2**	**high CO_2**	**ambient CO_2**
Rhizome C:N ratio	22.9±0.4	25.8±1.2	23.2±0.3	21.6±1.3	24.9±1.2	25.0±2.3
Leaf carbon content (%)	34.6±0.4	33.5±0.4	31.7±0.5	32.5±0.1	33.3±0.2	32.2±0.7
Leaf nitrogen content (%)	2.2±0.2	2.1±0.1	2.0±0.1	2.1±0.1	1.9±0.1	1.9±0.1
Leaf C:N ratio	16.3±1.1	16.4±1.1	15.9±0.6	15.6±0.5	17.9±1.4	16.7±0.7
Carbon sequestration (mg C $shoot^{-1}$ d^{-1})	0.31±0.02	0.25±0.03	0.43±0.02	0.37±0.01	0.59±0.05	0.53±0.12
Shoot carbon content (g C $shoot^{-1}$)	7.30±0.41	5.35±0.47	6.51±0.26	5.30±0.12	6.55±0.91	5.65±1.26

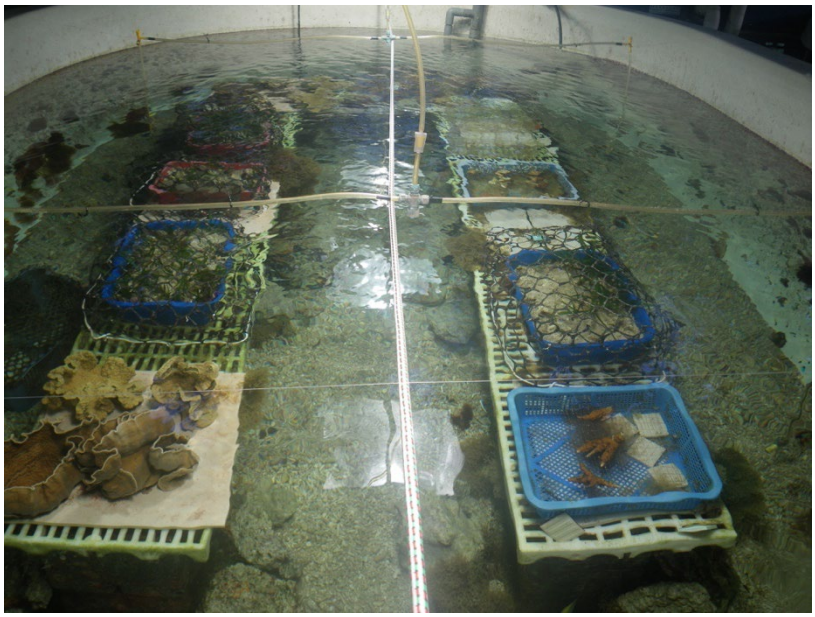

Figure S1. ***A representative coral reef and seagrass mesocosm.*** For scale, the length (longest dimension) of the bottom-right blue plastic basket is ~27.5 cm.

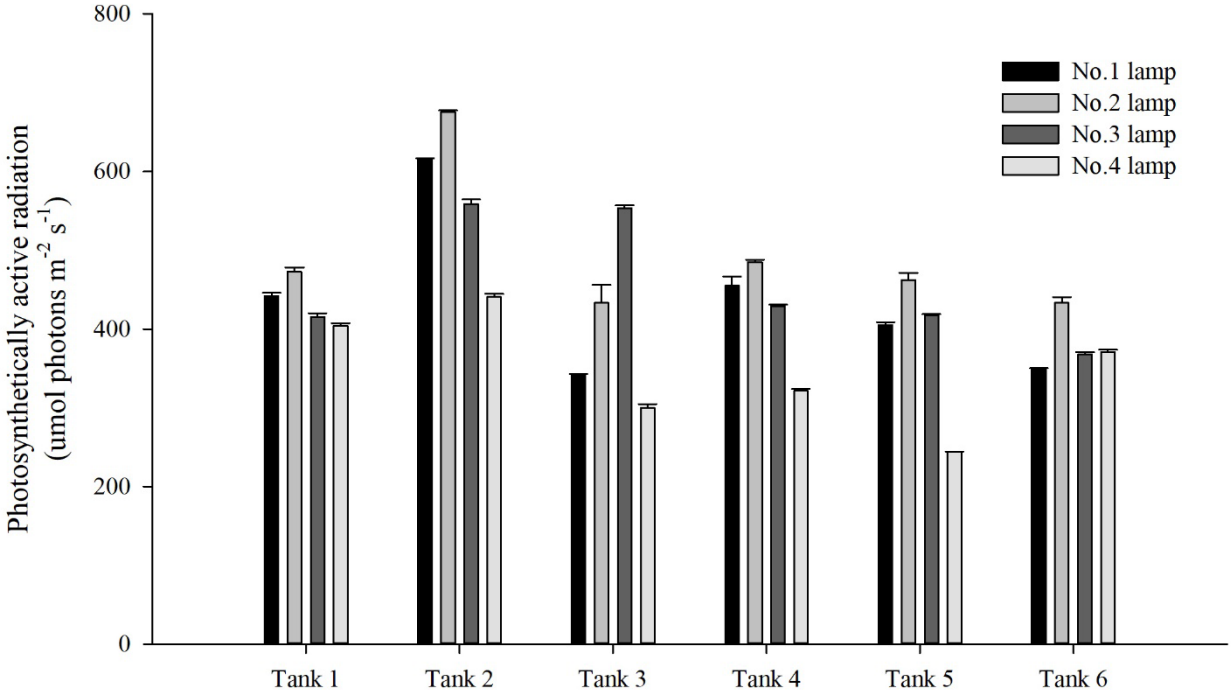

Figure S2. ***The photosynthetically active radiation (PAR) at the seawater surface under each lamp of each tank.*** Error bars represent standard deviation (SD).

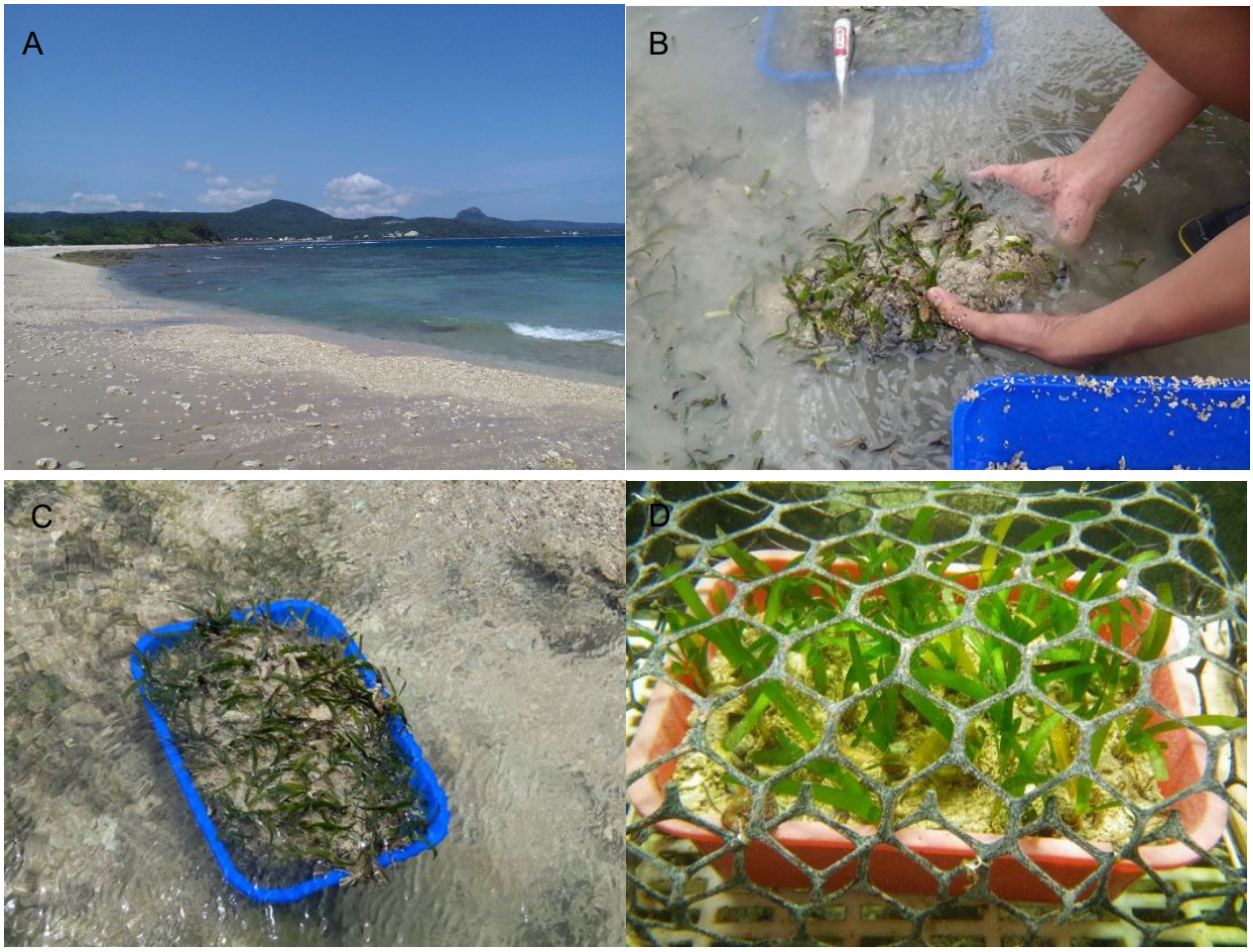

Figure S3. ***The seagrass bed study site.*** (A) Dakwan, Nanwan Bay, Southern Taiwan (22°03'N, 120°42'E). (B) Removal of seagrass (including roots & the associated sediment matrix) from the seagrass bed with a shovel at low tide. (C) Plastic bins later transported to the experimental mesocosms. (D) A bin enclosed in a 4 x 4 cm mesh cage.

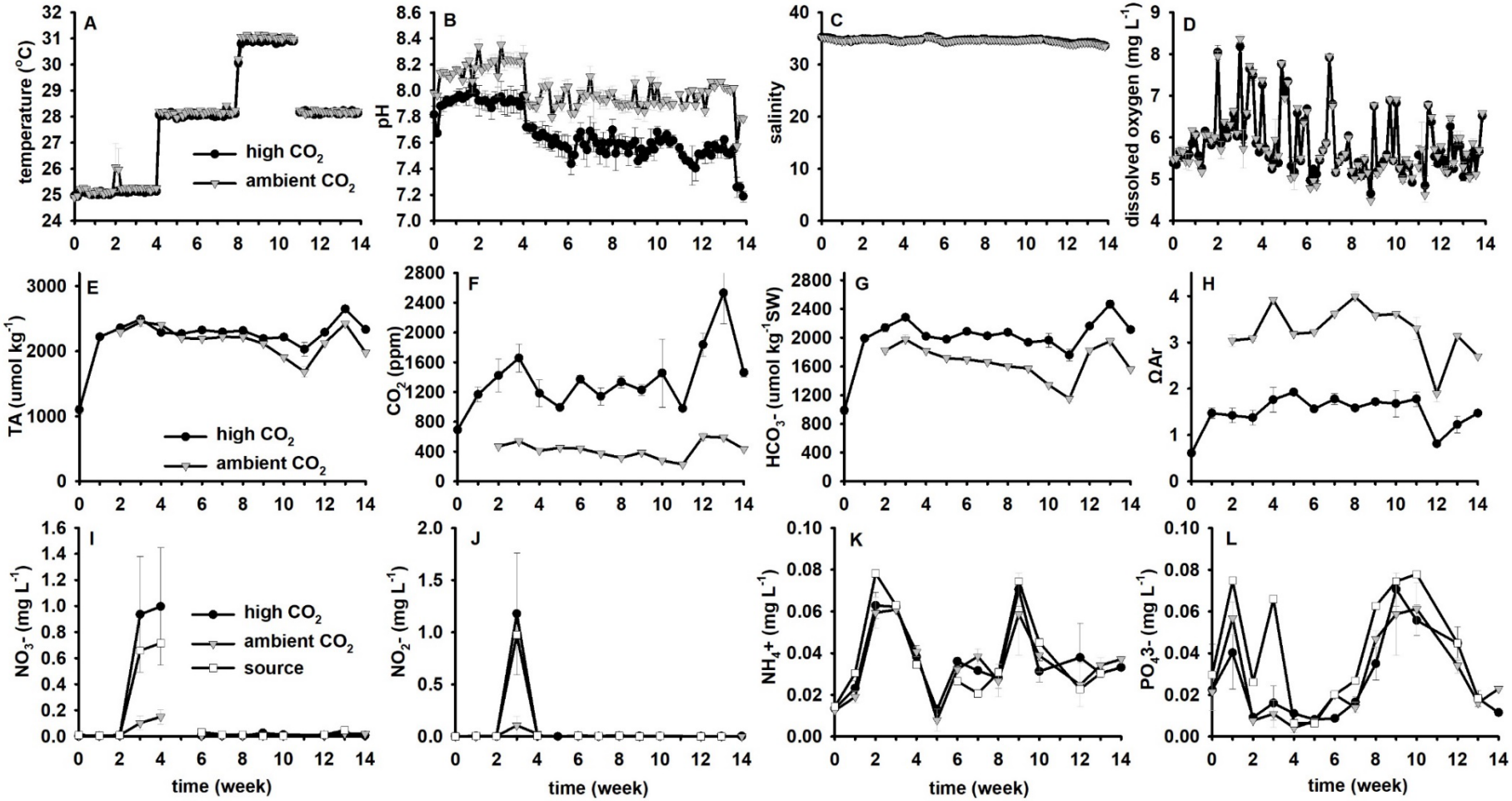

Figure S4. ***Abiotic conditions of the ambient (grey) and high-CO_2 (black) mesocosms***. (A) temperature, (B) pH, (C) salinity, (D) dissolved oxygen concentration, (E) total alkalinity (TA), (F) CO_2 concentration, (G) bicarbonate concentration ([HCO_3^-]), (H) aragonite saturation state (Ω_{Ar}), (I) nitrate concentration ([NO_3^-]), (J) nitrite concentration ([NO_2^-]), (K) ammonium concentration ([NH_4^+]), and (L) phosphate concentration ([PO_4^{3-}]). Values represent mean±SE (n=3), and error bars sometimes do not extend beyond the icons (e.g., [G]).